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(73) Proprietor: Al'tshuler Grigorij Borisovich

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(54) APPARATUS FOR LASER TREATMENT OF BIOLOGICAL TISSUES  
(ALTERNATIVE EMBODIMENTS)

(57) Abstract:

FIELD: medical engineering; surgery; orthopedics; stomatology. SUBSTANCE: proposed apparatus comprises at least one receiver of information about condition of biotissue to be automatically controlled. Receiver output is connected with input of control unit. Apparatus further comprises electronic switches arranged in current supply circuits of lasers and controlled by output signals issued by control unit. Finally, apparatus comprises two or three lasers emitting radiations at different wavelengths and having independent outputs. EFFECT: improved design. 7 cl, 5 dwgs

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(56) References cited:

WO, naTeHT, 90/12548, mu. A 61 N 5/00, 1990.

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(54) **YCTPOYICTBO J~JISI JIA3EPHOL1** OBPABOTKLI BVIOJIOP14<sup>I</sup>IECKOLI TKAHII  
(EPO BAPIAHTbI)

(57) Abstract:

I'ICHOnb3oBaHHe: H3o6peTeHHe OTHOCHTCя K Meл[HL HHCKOли TexHHKe H MO}Ke'r *66ITb* Hcnonb3oнaxo B xHpyprHH, opTone **nu u** cToMaTonopH. CynжoчTb H3o6peTeHHc: aBTOMaTH<sup>I</sup>leCKHe KOHTpOл COCTOяHHя o6paбaтлBaeMotи **6HOTKaHH H ynpanneime** напaMeTпаMH H3ны<sup>I</sup>leana на3epoa RocTУraloTCSI 6нaroj;apsi CoBOKypHOCTH BBejjeHHbix B ycTpoficTna *xOTB* 6b1 OJHOpo IlpICMHHKa HH4)OpMal[HH o COCTOяHHH 6HOTKaHH, BbIXOg KQTOporo coceHHeH c BXOjOM 6ноia **ynpasneHux**, H 9MOKTpOHbIX x.mofeLL, yCTaBOBJCHHbIX B IjenSIX rHTaHHcI на3epOB H yнаBнnleMbix BbIXOJ(HbIMH CHcHanaMH 6ноxa yнpaneHHcI. Hanm<sup>I</sup>He B OAHOM yCTpOICTBe AByX HnH Tpex на3epou c па3TDX'mbIMH ,HnHHaMH BOTИH 113ny<sup>I</sup>leHH2 H He3aBHCHMbIX BbIXOgOB, a TaKJKe B03MO}KHOCTb CMemXBaHHH H3nyueHHI 9THX на3epoB o6ecnex-nIBaeT B03MO}KHOCTb TpebyeMOlo, OpHeHTHpOBaHHOpo Ha MHHLIMalbHyo HHBa3HBHOCTb pe}KHMa o6pa6oTKI. 5 yin.

-£-

I4110XI9a 'ISNHauaEduX E310119 rnoiox 3 H2HIIIM03 tfoXI9a E 'RHEX.L EH HNHLLouatffOa  
no,L3aw a Halaudio3 oIodo,Lox loxa 'NHBxs kIOxaahL.I0110Ng NNHHO.L303 o NLYIEI'd0(I)HI-  
M1Iny I4du Hato I4g H,LOX Hatfaaa 'EH.LONod.Latt NIOtloXI4a N2x3ahw.Luo Ha.Lauuu o.Iodo,Lox  
tfoXI4a 'Y40NHhaHOHEH 3 OHBOUGH 303133hLLUO Y4N ANia.LJHO oiSmo[rtdhaLxo(I) EdafEu  
O.jodo.La 1130 903133hLLUO EH OlmHH3UHOHE,La2C 'OHHOHLLasaaLL003 aodaEu o odo.La N o oadau  
XHoo EH I9Haxcououaud alado,LoH 'Euemdaf EdafEU o.Iodo.LH mama rHauh' H11tf aoahEdfOdu  
H Bdaf8u oloadau Imliuoa Iunwh' Huff aox9uaLawad,Lo oHHN,Lxauaa LI al{4ua,LaXcad,Lo  
az4HHawIcduo a Nxaanz uo 'I4H4uauuedau XI4do,Lox Nao 303laah0,L110 'I9dafEu aIHo'uXul+IN  
'aodaEu ISNHELLNU Pto ioUg a I9H3111/111303 oaodo,Iox I4tfoxi a 'ISNHauaeduc 310119  
aatna3adatfoa 'HHExx HOxaah0LIO110H9 113Is09Ed90 VoudafEu IsuYI oa,LoNod,Latt H O,Lh 'NaLL  
ISO.La'BUH.30tf ISHha,LadgoEN NNHaIfa.1,31Itta0 Ndu .LES9uuCfad 1 1M33hHHX3,L HI9HII8EE3IA

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o.IatfIOHH110U9a 'NHEX,L 00M33hN.I0110N9 ail LO98d90 HoxdafEU 15O1 BHSaLIod LatC NNIEt££Oa  
a 03.L3EhOIUx££ '3H4Ha,Ladgo£N 30NlaISICHKE£ oxauaBduBH LIodo,Lox aHHamad EH 'EhEtIE~

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9.LOOH3E11O H f0J dtf x Hx,Loged90 alma, o.IoHY(O anawad ,Lo atloxadau Ndu ISNH3H3Nudu  
oaa 9,LaoHaN,Lx344E 11eHhO,LE,L3o113H Ha.L3HicHH ElaLoLOdu Niox,LE.LOOtfall IlaHHHOHoO

•OjOdO.La KNHahAu'EN I914uou I9HLLutf £ulf aouhld£odu H EdafEU o.Ioadau HNHanetu£H  
rnuroa i£HHute Butt aoH4ua,LExcd.Lo OHa0LLxauaa a L '30HhIOdxfl1 EdafEu ouodo,La  
Hao EH E 'aoH4uai,g a d,Lo 'adaceu oJoadau moo EH 3oHH33KOI1ou0Ed 'OUExdaC 'I4IOH310110H  
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EII 'I1OxNNh3110BEH 3 BI1310110a O.IOxaahH,LUO 310£2d3A H A Ia.L3H3 ouQIIOI&dHoAxOH  
'edafEu oaodo.La u3o HOHaahH,LUO EH aI9HHawouou3L'd 'I4H9uauuedeu xlgdo,LOa  
1130 aHxaahH,LUO 'edafEU xrnIa4Ulc1n a eat( 'HNHau aduA 310u9 J modatfoa oa.LoaoJ.o& o.L£

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VOds3I49 4,L3o13110A£0H3H 113sa1SIH HESaHOD,La1C 0,I0HHEt1 Y403IsH L3Ot1aH PIHhH0H00

'I4dafEu wlgaaagde aua I£I4PIaHN14iIO.I

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'Ea.LOIjod.L3 notfox4a HO.Lauua £ tfoxI4a E 'HHHO110a O.IOMOahH.LNO P101FOXI4a 3 Haxcuduo3  
11MO3bM.LUO O.IODO,LOx i'oxa 'OHHhDHOHBH H 'EdafEu vtotfoxI£a o HaSKHduoa HxaahM.LUo  
oaodosox t10XH 'aH3I0110a 0.I03133hH,LUO xofads0 331110(EhOIU}Ia '691C£ x I111HaluCIH£H  
HxaE iootf oa.LOtfd3 H dafEU grum IuACIU^IH Ha0 ROxaahHLLUO 4uotfa 3I9HH3)1C0LION3Ed  
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a 0HBaO£4u0113N 4sI49 .L3MCONI H 31Nxxa.L U0x3HN11NtfaN1 x ISO.110o11,1,0 aaHasadgofyI

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 x H1iKUIHahOIHAttOU 'HNIEHEL 1tH HNI<sup>2</sup>HJ.HH.IENIOdJ.xaue HaxC9EH3 HNIEItaoaduoxtttt<sup>2</sup>Oa  
 IsHHaHHtiaO0 a.laaNl a doaaduNiox aIq arAl<sup>2</sup>OH E 'EHJ aHODj a~i HNIEtfoXI9a Lu'u9HHou' IEJHdda  
 ISO.LOH LcaU H XEAHHhaHO31 H a I4HOHH11a<sup>2</sup>L90 xl<sup>2</sup>do.Lox I4t1oxi a 3HiUOIAa,La.LaaJ,003  
 'Edo3aadu<sup>2</sup>Iox o.Ioi m<sup>2</sup>A t<sup>2</sup>oa H Nloaoaa Nu niT 1foa Igt1oa Trutt EdEAada<sup>2</sup>ad <sup>2</sup>Li  
 v\_Januso.Laoa 'nni ogadgo MHO<sup>2</sup> HHHamlodo HONlaJ.3HO OHa3H9EHa oa,Loaoda.a1c oueua.LHHUouorj

•ISua.LEhollnladau o ioi l4iCdxuadJ.xaue  
 nun alOaoxanlfoadH UOH<sup>2</sup> altau a Haxuoul<sup>2</sup>a 4.LI49 .L3WONI hOIL3I HI4HHOd,Lxauf

.098>p>0TT :omaolfa& 5nonsdoaiuaolfC'<sup>2</sup> P UOJ& EHHHhOHOHRH alfOXa  
 EH 1100 HOxaahH.LIIO NlaHauURdHEH a .L.IHHIE1.300 HLi OOWILCd,LHUSaa&h I![OHglranmonar 1 oaa  
 aHHauHedIEH O.Lh 'NIOcEdgo NHME.L 0.I0HHauBOHE.Ia4C 'EaHHNlandu 0.I03IaahH.L3JMe attH <sup>2</sup> a  
 Haxuoulga ono 4.u49 J.axCONI HHEXj. YIO3I3ahH.I0I(OH9 HHHISO,L303 0 avinumdo4HH MHHI4audij

•EdaeEu IchHahtCu<sup>2</sup>gH MHHNlandu EH aMHEtIEUOU HatnOUehOITl3H  
 'ISHHExaAu0du lOaouou a d.L4UVt\$ <sup>2</sup>adah HONla.L3Ha vlaJna~idaaA o~ 11 EdaeEu mourmdae  
 l' mHZfoxl4a Atwan EdaeEu moo HoxaahH.LUO EH oarwaxrououaEd 'EUExdae ouoiw.odoaou  
 woa.Latiad3oH gHEi.L EH ISHa.LoHaticea 11O.Laa14 a <sup>2</sup>0<sup>2</sup> duoa HHOOhHJ.uO o odoxo3l  
 1oxa 'ISHHahAu<sup>2</sup>gH OJ0HoadBED4HH Ex11HNlaadu o.1oxaah!d.Lxauco.Lo4 attaa a nauuo 4a  
 4Jd49 J.a3KONl aJkMEJ. HHEM.L 15OMOahH.IOUGH9 M11HISO.L303 0 HHYIENIdO4HH MHHlaa ldl

•ISHHanaEda E.LHaNlaue H aodoixaxalfoi.o4  
 HM laHHU 'E LHaWaue 0,10HHOH3dau3Htt <sup>2</sup>gH 0.I321ISO.La03 11 YHEX.L Eli ISHU.Lal/lat<sup>2</sup>oa NIO.L33NI  
 a Haxcxduoa Hxa0hH.LUO O.IOdO.LOM tiox a 'NH 005I-00Z H.L0EIf90 H Edo.LE<sup>2</sup>gHUEHEOd.Lxaau attHa  
 a HoH11OUI4a 4.u119 J.LOHCOI<sup>2</sup> HHE3.L LIOxaahH.IOIOH9 HHHISO.L303 0 HH<sup>2</sup>i ENIdo(I)HH 314HYQ3Hdj

'ISHHEJ.111 NIOSIOLC9 a Eda<sup>2</sup>gEII O.IOfxCEa ISHH3HHtt30a xiciiio 1 a XlghHOIOIOHE.L3A  
 variorum xI4HHQd&.xaue HNIEIfoxa a I4110HH1a0a o.10do.LOX Ighoxiga 'HnHallaudaA  
 among kolloxa aaH1llaoa Vox:ma '9IIEXj. EH HLIaLagaltCoa WOJaa1l a HaxcIduo a  
 o.Iodo.IAx ItOXa 'HnExj. UO3I3ah11.I0IIOU9 HHHHO.Laoa 0 <sup>2</sup>HHZIENIdoltHH NIOMHHNloadu NIHHIO  
 149 .LOX OHMIC9EHO aMCXL',L oa.I,3 odL0A 'EaJagocd.La& 1114EIfOxa HNII313ah11J.UO -Ha.LOISICHH  
 x14do.i.ox I4lfoxi4a 'NIOxLIHhaHonaH H OHxou0a a0x30hH,LUO H EM L31113 HElnoadMa1Cxol))  
 I4HaMCououaed HHHahtcirCH Max on oHg1Ca.LEaotfauoou aodaveu oja4.LadL. H oaoadau gaao ca  
 v\_I0ZSKL'xEH '010.L mod)! 'EdaeEu o.IOdOL.a moo EH X14HHaxc0110uo13d 'EHMOLfOa OJ0x33h11J.110  
 mltoxa 11 Y[ONIOLOIa Z3aluo(std113dx0cir 'EdaeEu 0.Ia4J.ad.L rim EH NII4HHa1Ja0HE.laA 'WOLIExdae  
 NIgl1<sup>2</sup>UJ.LEXced Lo 3 aoHHaxcsdu0a HxaahH.LHO 'OIIExdae aodae1lf oaodo,La 11 o,ioadau  
 mama I4HHulf Hull aoHhEdeodu H EdaeEu o.Ia4J.adJ. mama i rm& Hutt aoH4uaLraId.Lo  
 oHa11J.xallaa aodO.La OH3Ua0HEJaA Nlcl(Bxdac Nu4Ha11J.xaL(oo Ee EdaeEu au: do e  
 Ha0 Iq0x3ah11LIIO EH •HHHOb<sup>2</sup>fSCH Eh'OX CH XH EZV0H14a o14J.30Hxco14eoa a r1H3Ica0HE. alt  
 ELCExdae aI<sup>2</sup>E4uaJ.EHCedLo Nlahidu 'ouRxdac a OHg1la.LE10EdJ.O oHa1HOHE.L0A Ho0  
 Oda EH E. 'aOdacau xLIAdif xAall NIHO0 I'QHxaahIJ.HO EH4lfauuldaU O.IOdO.LOH 400 ISEx3ahHJ.110  
 'beau ur<sup>2</sup>aI3qu1CUNii va,LadL Hatfaaa aaJo odJaA wolioxl4a NIHM00hHJ.IIO HaLoauaa  
 O.IOdO.LOH ItOX14a 'YQOxIIHhaHOMEH a OHxOII0a a0310ah1.LUO 11 AYIO LOH0 ef no AdaaA io4 adacau  
 oaodo.La 11ao LI0HaahHJ.u0 EH aI9HHaua0HEJ.3tt 'OHHOEL a LaaJ.00a aodacau o.Iodo a H o,ioadau  
 X1100 EH I iHaHC0IIIOUOEd algdo.LO3 'Ei idae EdaeEu oaodOLa 19HU'Oa 19M/1vw Melt aoHnadcodu  
 H EdaeEu oaoadau Iquuo a I4H11ulf athi aoH4uaJ.EHcedLo OHIHJ.HOUOO 11 aofqua.LEMCedL.O  
 arcancr cHdu0a H1133h11.Ln0 'P\*iquauuEdan xlgdo.LOM H30 OH3130hLLHO 'Macau  
 aI4Ha4IL.fuv4a 'aoda<sup>2</sup>gEU HarrexaU L4oxou9 a 14FI3H11tfaoa olodo.Lox Iallaxlga 'ISHHalfaadlli  
 x0119 aaluExcdatafoa '1IIEExL HOxaahH.I0uoI9 11MJA9Edg0 IcoHdacEU Hull OHJ oYIOdJa/~  
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 EdaeEu oaoadau H30 VOx3ah11J.UO EH E 'HIHahAI(gH EZfOX CH Oda EttoaI4a ol4J0hJ)KOYQEOa  
 3 OH0IIaOHEJa1t OIIExdae aoli4Lca.LEXCedso •H ared,aU YQOx0u9 3 EdaeEu aIOti)KEM HIHOHHtfaoa  
 xHildll a XI9HHalfao4reLo 'T~ah01Ifx XlquiHODj.xaue HY4Et0Xa a 14HoHh11oo3 ouodoxox

143BeCTHO, <sup>1</sup>ITO 9 4eKTHBHOCTh na3epHOH o6pa6o'rKN 6NonorxTlecxolz TKann C OTrHOBpeMeHHbIM o6ecne<sup>1</sup>leHHeM H113KO2 NHBa3NBHOCTN (CreneHH HeKp03a) 3aBNCNT OT MINHbI BOTHbI N MOnLHOCTN na3epHO N3nytleHHH, 3Heprn N BpeMeHH na3epxopo B03TjelICTB4H, a Tjnh HCKOTOphIX BNTJOB TKAH4 zKNTjKOCTHOPO OpomeHH 30HbI na3epHOLI o6pa6o'rKN (cM. HanpNMep Proceeding of. Laser-Tissue Interaction V 24-27 January 1994. Los Angeles, California Vol 2134A).

NccnegoBaHNH, npoBeJeHHMe anToM, noxa3anL, wro npN 9ToM Heo6xoJNMa OT(HoBpeMennaB OnTNMM3a1I 1st yKa3aHHbIX napaieTpoB A SR Ka c opO Bill a 6NOTKAHN. I4HbIMN CnOBaMN, He0XOT(HMbI: BO3MO}KHOCTh Bb160pa OHTNMaJlbHbIX MIIIH BOMH N3ny<sup>1</sup>leHHn na3epo rum Nx CMedu, perCTpaunH npocecca na3epHOTi TjecTpyKB;NH, BNTja N COCTOHHH 6NOTKAHN N ynpaBneHLH TjnlHOLI BOHbI, MOIIWOCTbIO, 9HeprLe2 N BpeMeHeM na3epHO TgeicTBN51, cHcrema OpoineHHH 3OHM na3epH01<sup>1</sup> o6pa6OTKN.

COBOKypHOCTb BBeJeHHbIX B yCTPOLICTBO XOTbI 6bI 0,14HOPO npaeMHNKa 14H4OpMaljLH O COCTOHHHN o6pa6aTbIBaeMOa 6aonorHecxon TKAHN, BbIXOTj KOTOPOPO COCTINHeH c BXOgOM 6noKa ynpaBneHHH, N 9neKTPOHHbIX Knloue2, ycTaHOBJeHHz 1x B ijemix niTaHHH na3epOB N ynpaBneMbix BbIXogJI IMN cllpHanaMH 6noKa ynpaBneHHH, npe)jcTaBnHoT co6ofl CNCTCMY o6paTHoi CB513N, KOTOpal o6ecneennBaeT an'poMaTN<sup>1</sup>lecKHe KOHTpOJb N OHTNMaJlbHOc ynpaBneHHe napaMeTpaMN Harly<sup>1</sup>leHHH na3epOB B 3aBHCNMOCTh OT BNTja N COCTOHHH o6pa6aTbIBaeMO2 TKAHH N 'rem CaMbIM o6ecnewBaeT MNHHManbHyio HHBa3NBHOCTb.

Heo6xoJ aMocTb aBTOMATH<sup>1</sup>lecKHX KOHTpOJcI N ynpaBneHHH BbI3BaHa<sup>1</sup>iaCTO B03HNKa1011jeH HeBO3MO}KHOCrb10 B143yabHOPO OnpCTjeHeHHH Bpa<sup>1</sup>1OM COCTOHHH o6nyTaeMO2i TKAHN N ee BNTja.

Hanatlac  $\tau$ ;ByX HC31311CNM:1X BbIXOT(OM B OT;HOM yCTPOICTBe 6napoTjapH H03M07KHOCTh BbIBOTja OTpa}KaTenbHOPO 3epxana 143 xOT(a 113JlytleHN51 Ilepnor0 na3epa, a TaK}Ke BO3MO}KHOCTh CMeuLBAHHH 143JlyUCHN2 TjByX na3epOB IOBbIHaeT 9(4eKTNBHOCTb pa6OTbI ITN o6pa6oTxe 614OTKAHN N o6ecne<sup>1</sup>mBaeT CHH}KCHHe HeKp03a - .. ..

HanatlHe B OT(HOM yCTPONCTBC T(n51 06pa6OTKN 6NonorrmecKo2 TKAHN TpeX na3epOB c pa3n<sup>1</sup>HHbIMN T(fNHAMN BOJH N3ny<sup>1</sup>leHHH N He3aBHCNMbIMN BbIXOT(aMN II c BO3MO}KHOCThIO CMenIBaHHH N3ny<sup>1</sup>leHHVi o6ecne<sup>1</sup>laBaep HaN6OHyIyIO M06NJbHOCTb npaMeneHHH yCTPOLICTBa N MaKCNManbHO pacmJapHe' ero B03MOXHOCTN. HanpIMep, npN OTjHOBpeMeHHOM B03}2eICTBHN POnbMHeBbIM H HCOTJNMObbIM na3epaMN Ha o6NnbHO KpOBOLIacbinjaloune opaHbI CHNMaeTCH OuaCHOCTb KpOBOTe<sup>1</sup>leHHH npN HeCaHKILNOHNpOBaHHOii nep4opalj1N KpyHHbIX KpOBeHOCHbIX COCTaB. MIA CMeUINBanNSI N3ny<sup>1</sup>leHHH TpeTberO na3epa c T(ByMH T(pylMN Him Ka?KT(b1M 143 MUX BBCgCHbI OTpa?KaTenbHOe H ceneKTNBHOe 3epKana, ycTauoBneHHble COOTBeTCTBHHO K OCSIM TpeTbCrO N DTOPO 11a3epOB, a BO3MO?KHOCTh BbIBOTja OTpaKaTCTbHbIX 3epxan N3 XOTja 11311y<sup>1</sup>ICHN51 14 Han1gle T(ONOTIH4TC11bHbIX ~OKyCNpy1On)ITX CNCTeM H OHTN<sup>1</sup>ICKIIX BOTOXOH o6ecne<sup>1</sup>rDaeT lie3aB11CNMOCTb TpeX OHTN<sup>1</sup>lecKHX BbIXOT(OB yCTPOICTB.

AOIOJHHTenbHO BBe}CHaH B yCTPOLICTBa CHCTeMa OpoineHHH, ynpaBneMaB 3nCKTPOHHbIMN KllanaHAMN, IOT(Kn1O<sup>1</sup>leBHHIMN K BbIXOTjaM 6nmKa ynpaBneHHH, o6ecne<sup>1</sup>lnBaeT onTNManbHOe coreTaHHe ne?KHMOB o6nytleHHH N OpOHeHNSI TKAHN.

COBOKyIIHOCPb N3n02KeHHbIX B 4 opMyne N306peTeHN31 npl3HaKOB HbHeTCH HOBOJI, a canto TexHN<sup>1</sup>lecKoe pemene yTOBJICTBOpICT Kp1TepcI10 "14306peTaTenCKNLI ypOBebb".

Ha Ipar.1 N306pa?KCHA CXeMa ycTpoicTba Tjns na3epo i o6pa6oTKH 6NOTKAHN; Ha 4Nr. 2 CXeMa yCpOLICTBa npN Hana<sup>1</sup>n4N TpeX na3epOB; Ha (MP. 3 CXeMa BapHaHTOB BbINOJHCHH II pacnono2KeHHH npHeMHKOB NHd opMaluNN O COCTOHHH o6pa6amIBaeMO2 6NOTKAHN; Ha tMr. 4 cncTeMa opoieulln 30HbI o6pa6oTKN; Ha (DNr.5 6nox-CXeMa 6noia ynpaBneHHH.

VCTPOLICTBO anH na3epHoi o6pa6OTKN 6nonorH<sup>1</sup>lecaoik TKAHN 4Nr.1) COCTONT 143 6noKa ynpaBneHHH 1, COe, (NHeHHOpO c H14M 6nox nsTaHHH 2, NMnybCHbIX na3epOB 3, 4, cocj HICHbIX c 6YOKOM nITaHHH<sup>1</sup>iepe3 3neKTPOHHble KnlO<sup>1</sup>IN 5, 6, KOTOpble no KnlO<sup>1</sup>leHbI

**К** BbIXOgaM 6ноха ynpaBneHHn 1. Ha onTLIuecKnx coax naoepoB **3, 4** pacnono?xeHbl CoOTBeTCTBeHHO OTpalKaTenbHOe 3epKaJIo **7** и CeneXTMBHOc 3epKaJIo **8**, KoTOple onTHuecKI conpH KeHbl MelKgy co6oa **с** (поKycHpylonjeLI encTeMoh 9 H BbIXOgHbIM TOPIOM OnTHueCKOpo BOJIOKHa **10 с** HaKOHе 'HHKOM **11**, pacnon07KenHbIX Ha OITMUP.CKO\$ oCH na3epa 4. CeneKTИBHOe 3epKaHO 8 oTpaIKaTeTbHO gnsI H33Iy'ieHHn C gTИHHOI BOnHbl na3epa **3**, no npo3patuo Rnn H3nyeHnn c gTИHO\$I Bonn i na3epa 4. Pacnono}KeHHoe Ha OITHueCKOИ OCH na3epa **3** oTpaIKaTenbxoe 3epKaHO 7 nOgKpИOueHO K BbIXOgy 6ноха ynpanneHnn 1 H B 1101102KeHHM A ycTanaBannaеTCn nog yrhoM **45°** x ocil, a B non0xeHHD1 B napanneim o eft. Ha 9TOLI lice oCH ncneg **3a** 3epxanoM nocnejjioBarenbHo no xony M3nyeHHMH pacnonozeIn 1 4)oxydHpylonjan cneTeMa **12** n onTHuecxOe BOTIOKHO **13 с** HaKOHеuHHKOM **14. К** BXOgy 6ноха ynpannenHH 1 nogxmo<sup>g</sup>eH 3неKTpnueCKHI BbIXOA nPIeMHHKa HH(popMaHy 1 o COCTOHHHM 6HonnnecKoИ TKaH1 15, BXOg KOTOpo COIIpHHTeH c MeCTOM B03jjeICTBИH Ha 6ИOTKaHb 16. CHCTeMa nppnax nzi **17** no)IUnIOUexa K TeM KC BbIXOJaM 6ноха ynpaoneHЛИSi 1, 4TO 11 6nox nHTaHHH 2, a ee Bo \$HOYi n Bo3,ByIBHb11 BbIXOgbl 18 M 19 o6'begmneHbl B HaKOae 'HMKе 11 (14).

Ha (Dnr. 2 npegcTanneH BapHailT ycTpOICTBa c TpeM\$1 na3epain 3, 4, 20. Ha onTz1 ecKovi oCM na3epa 20 ycTaHOBneHO oTpalxaTenbHOe 3epKaHO 21, KOTOpoe Tax Me, Kax H oTpalKaTenbHOe 3epxano 7, nogKnlouexo K 6nOxy ynpaBneHlin 1, H B non0KCHHH A yCTpaHaBnHBaeTOH nog yrhoM 135° K onTHueCKOИ OCH, a B HOnOJKeHHM B - napan.nenbno eLI. Ha 9TOLI lice onTИuecoИ oca pacnonoIKeubl 4)okycHpylonia\$ cHCreMa 22 H BXOgHOLI Topeu OnTHueCKOpo BOJIOKHa 23 И HaKOHеuHHKOM 24. MewK,ny (поKycHpylonjeLI cHCTeMoИ 9 H CeTeKTHBHbIM 3epxanoM **8** ycTaoBneho BTopoe ceneKTMBHOe 3epKaHO 25, xoTOpoe onTMueCKM ConpH?KeHO **с** 3epKaJIOM 21, (poxcHpylonjeIK CHCreMOLI **9** n BXOgHbIM TOPI(OM OnTHueCKOpo BOnOKHa 10. CeneKTИBHOe 3epKaHO 25 OTpalxaTeJbHO grin n3JTyeHH31 C gnHHOLI BOfHbl na3epa 20, He npo3paLHO grin H3nyUCHLI C gTИHHaMH BOJIH na3epOB 3, 4. BnoK rHTaHHH 2 coegИHeH **с** na3epoM 20 uepe3 9неKTpOHbИИ KpИOУ 26.

Pa3HOBIHOCT\$MH npHeMHHKa ИHTИOpaMILIM 15 O COCTOHHHM 6HOTxaHH 16 MOpIT 6HTb KaK CнеKTpOaHanH3aTOp 27 (4nn'.3), BXOg KOTOPOpo OHTIZueCKH conp51 KeH c MeCTOM B03geICTBИH Ha 6HO TKaHb 16 H COCTOИИ(HLI 143 gHCnepCMOHHOPO 9JTeMeHTa 28, nHHeIKH 44OTOgeTeKTOpoB 29 И 9JICMeHTa CpaBHeHHcI 30, TaK H (OT09TICKTpWueCKMLI npHeMHHK HH4ppaKpaCHOpo H3nyeHHMH **31**, OITИueCKИ4 Conp\$ИKeHHbИИ **с** MeCTOM B03geICTBИH Ha 6ИOTKaHb 11OCpegCTBOM OnTH'leCKOpo BOTIOKHa 13 (10. 23), (поKycHpylonjeLI CHCTeMbI 12 (9, 22) И fOBOPOTHOpo 3epKana 32, pacnono KeHHOpo Mcлuipy 4 oKycHpyloueи CHCTeMOИ 12 (9, 22) H 3epKaHOM 8 1JИH nenocpegTBeHHO nepeg BbIXOgBbIM 3epKaHOM na3epa 3 (20). llepeg OnTHueCKHM BXOgOM (4OT09неKTpИueCKOpo npHeMHHKa 31 ycTaHOBneH MH4paxpacnbИ 4pHnbTp 33, nonoca npOHyCKaHHH KOTOPO ncKpИOuaeT nonagaHne Ha 4)OT03нCKTpИueCK11 npHeMHHK 31 143nyeHHcI na3epa. B KaueCTBe npHeMHHKa HH4opMaцИИ 15 O COCTOHHHM 6HOnOpH TeCKON TKaHИ 16 *мoжeт* 6bITb И aKycTHueCKHИ npHeMHHK 34, paCn0n02KeHHbИИ 116111131 MecTa B03geICTBMn Ha TKaлb TaK, 'ITO HanpaBpHeHepo MaKCMOJbHOИ UyBCTBHTeHbHOCTH COCTaBpИeT **с** onTMueCKOLI **00,10** H3nyeHH51 Ha BbIXOge HaKOHеuHHKa 11 (14. 24) ypon a, ne nanyuИ B npeganax oT 11 go 86°.

**В** CBИ3И **с** TeM, **1TO** MHCJIO npHCMHИKOB HHd)OpMaUMH O COCTOHHИИ 6HOTKaHH MOKT KOne6aTbCH OT OгHOPO go гCBHTH (nO Ka?KгOMy BИJy, OKOMO Ka2KгOpO HaKOHеUHHKa), KOpИUCCTBO BXOJIOB 6ноха ynpaBneHnn *можeт* 6bITb paBHO геBHTH.

CMCTeia opomeHnn 30x.1 06pa6OTKH 17, M3o6paxceHHaH Ha 4)ir.4, COCTOHT 143 пe3epnyaapa grin BOgbl C BOgHHbIM HaCOM 35, x KoTOpOMy npMcoegMHeHa BOg0npOBOJHaH Tpy6Ka 18, n B03gyIIIHOpo xoMnpeccopa 36. PpHCOегuHeHHble K B03gyIIHOMy KOMypeccopу 36 B03gyXOnpOBOгHиMe Tpy6иn 19 CHa62KeHbl 3HeKTpOMapHMTbIMM xnananaMM 37. 38, 39, xoTopи ie nogJИloueHbl K TeM lice BbIXOgaM 6ноха ynpanneHnn 1, yTO H 6n OK nMTaHMA 2,tlepe3 nHHH 3agepxcicn 40, 41, 42.

ycTpouCTBO pa6oTaeT CJИepylonjHM o6pa3oM. I43JИyеHnn na3epoB 3, 4, 20. B cnyvae HaXOJKeCHM51 OTpalKaTenbHbIX 3epxan 7 M 21 B ИOn0KCHHH B, npoNgi (4OKycHpylonje CHCTeMbI 9, 12, 22, OnTгeчeчe BonoicHa 10, 13, 23 M HaxOHeHHKM 11, 14, 24 nocTynaIoT

Ha OUTH<sup>1</sup>leCKMe BbIXO)TbI yCTPO ICTBa.

Ecnn OTpa?KaTenbHble aepxana 7 H 21 HaxO 5xTCa B HOTIOncHHH A, H3Tly<sup>4</sup>leHHe na3epa 3, OTpa3HBIUIHCb OT 3epxana 7, nonaJ aeT Ha ceneKTHBHoe 3epxano 8 H, oTpa3H iimeb OT Hero, Hanpannclercn ngonb onTH<sup>1</sup>CCI o l oCH na3epa 4. A Hanorntnio. npH HanxtmL na3epa 20, H3nyeHHe na3epa 20 OTpa3HBIIMCb OT 3epxana 21, a 3aTeM OT CeneKTHBHOrO 3epxana 25, TaK%e HanpaHneTcs BJJonb OHTI ecKO11 ocn na3epa 4. B pe3ynTaTe, B CBH3H co CBOLICTBOM CeneKTHBHbIX 3epKan 8 H 25, B 4OKyc **ipyIondlo** CHCTeMy 9 H Ha OHTH<sup>1</sup>leCKH5 BbIXOJ HaKOH<sup>1</sup>nn3Ka 11 MOpyT nOCTynaTb H3ny<sup>1</sup>leHHH **BMX** TpeX na3epOB OJHOBpeMeHHO.

Bb16op BHAa npHemnmxa HH4)OpMaw n 15 o COCPOHHH 6HOTKaHH 16 3aBHCHT OT BHga TKaHH H pe2KBMa o6pa6oTKH, a TaIQKe OT BHJa HaKOHetiHHKa.11pn pa6oTe c HeKOHTaKTHbIMH HaKOH<sup>1</sup>niHKaMM OCHOBBaH MacTb B3Jly4HHH 3p03HOHHOpO 4 arena, B03HHxalolJepo H3-3a cBe<sup>1</sup>leHHH ygameMbxx <sup>1</sup>acTm 6HoTxaim, ne7KHT B BLIJ(HMO5 H 611HIKHIX ynbTpa4)HOneTOBO5 H HH(DpaKpaCH05 06naCTHx cneKTpa (200-1500) HM) H HBTICleTCSI npH<sup>1</sup>inHO5 HeBO3MO?KHOCTH BH3yambHOpO Ha6nlo)(eHas BHga H coCTOHHH 6HOTKaHH.

CneKTpanbHbIJ COCTaB H3Tly<sup>1</sup>leHHH 9p03HOHHOpO (arena 3aBHCHT OT BHga 6HOTKaHH, IOOTOMy Heo6Xo/ HM CneKTpaHbHb15 <sup>1</sup>aHaITH3 3TOpO H3Tly<sup>1</sup>leHHH, KOTOpOe nonajjaeT Ha gHCepCHOHHbnil 9neMeHT 28 CneKTpoaHanp3aTopa 27, paanaraeTCH B cneKTp H nonaJjaeT Ha nHHeIKy 4OTOJJeTeKTOpOB 29, cocI HHeHHJO c 3nCMETOM CpaBHeHHH 30. YpoBenb BbIXOgHOpo 3neKTpH<sup>1</sup>leCKOpO CHrHHana 3neMeHTa cpaBHeamn 30 COOTBeTCTByeT KOHKpeTH0171 KOM6HHaIH H JnHH BOYIH CneKTpa H3ny<sup>1</sup>leHHH 9p03HOHHOpO 4aKena. BneKTpH<sup>1</sup>leCKHil CHrHan OT 3neMeHTa cpaBHeHHH 30 cneITpoaHanp3aTopa 27 nocTynaET Ha 6nox ynpaBneHHH 1, r r a Bb1pa6aTbIaeTCH CHrHan H3MeHeHHH pexcMMA H napaMeTpon H3ny<sup>1</sup>leHHH na3epOB.

Pa6oTa c KOHTaKTHbIMH HaKOHetiHHKaMH CBH3aHa c HarpenaHHeM na3epHbIM H3ny<sup>1</sup>leHHeM Toplia pa6oiero HHCTpyMeHTa (BOTIOKHO HnH can4 LpoBbIl HaxOHennmx) JIo TeMnepaTypbl, JJOCTaTO<sup>1</sup>HO5 JnH pa3ny<sup>1</sup>leHHH 6HOTKaHH. HarpeB MecTa Bo3JJeLICPBHH OnpOBOMR aeTCH B03HHKHOBeHHeM HHcpaKpaCHOpo H3Jly<sup>1</sup>leHH53, KOTOpOe nepejaeTCH HO BOTIOKHy HaKOH<sup>1</sup>HHKa 11 (14, 24) H OHTH<sup>1</sup>leCKOMy BOJIOKH 10 (13, 23) B HanpaBneHHH, O6paTHOM XOJy 1Ja3epHOpo H3ny<sup>1</sup>leHHH, OTpacaeTcT OT HOBOpOTHOpO 3epKana 32, npoxoJHT HH4paKpaCHbI2 H HnbTp 33 H nonaJ aeT Ha 4oTo3neKTpx4eCKHIL npxeMHHK 31. 9neKTpHeleCKH5 CHrHan c BbIXOJJa 4 OT03neKTpH<sup>1</sup>leCKOpO npHeMHHKa 31 nocTynaET B 6nOK ynpaxuemmn 1, r)je B 3aBHCHMOCTH OT HapaMeTpoB 9TOpO CHPHana Bb1pa6aTbIaeTCSI CHrHan OCTaHOBKH, npo on?KeHHH H1IH H3MeHeHHH peaczMa pa6oTbI na3epa.

3KcnepHMeHTaHbHO yCTaHOBeHO, 4TO TenIOBOe H3Tly<sup>1</sup>leHHe, Bo3HHKaIOilee npH pa6oTe c KOHTaKTHbIMH HaKOH<sup>1</sup>HHKaMH, Haxo wren B rny6oxo2 IH(ppaKpacHon o6nacTH. B 9TO2 o6nacTH nyBCTBHTCJbHOCTb 4)OT03neKTpB<sup>1</sup>leCKHX npHeMHHKOB o<sup>1</sup>ICHb Mana. CneiTpanbnaX o6nacTb H3ny4eHHH na3epOB Taxxe nexciT B HH\$paXpacnoirt o6nacTH. 11o3TOMy nonOCA nponycxaHHSi HH4 paKpacnopo I:DHbTpa 33 cnaconana co CneKTpanbHO2 <sup>1</sup>nyBCTBHTeHbHOCTbIO 4 OTOnpHeMHHKa 31, c OKHOM Hp03pa<sup>1</sup>HOCTH onTHgeCKOpO BOYIOKHa 13 H o6ecnetlxnaeT HcKnlotexue nonaJjaHHH Ha 4 oTonpxexwmK 31 H3ny<sup>1</sup>leHHH na3epOB 3, 4, 20.

11popyKTbi nazepHoro pa3ny<sup>1</sup>leHHH 6HOTKaHH pa3neTaloTCH co CBCpx3ByKOB05 CKOpOCTbIO, L B CneJCTBHe peoxopo H3MeHeHHH AanneHHA H3-3a conpoTHBneHHH cpejbl rexepxpyeTCSI axycTHlecKas Bonn-Ia. Ann pa3THH<sup>1</sup>HnmIX TKaHC5 awnnwTyga aKyCTHMeCKOLI BOHbI paalzH<sup>1</sup>Ha. AMnnwTyJJa axycTmneCKo2 BOJHbI perHTpHpyeTCH aKyCTHHeCKHM npxeMnino 34, 3neKTpi<sup>1</sup>leCKHiiJ CHPHan c xoTopopo nOCTynaET Ha 6nox ynpaBneHHH 1, r)je cnHTe3HpyeTcH cmrHan BpeMeHHOLI OCTaHOBKH H3Jly<sup>1</sup>leHHB MHH H3MeHeHHH pen xi a pa6OTbx na3epa B 3aBHCHMOCTH OT THna o6pa6aTbIaionUeic TKaHH HnH B cnytlae npeHbneHHH 3HeprHH na3epHoro HMnynbca Hag nopOrOM paapynieHHH 6HOTKaHH, tITo BnxSeT Ha CTeneHb na3epHoro HeKpo3a.

11pexameHHe B cnytae Heo6XOJ14MocTH pexcxMa H3ny<sup>1</sup>leHHH na3epOB B COOTBeTCTBHH c

cHlrHanaMa CnexTpoanann3aTOpa 27, 4oT09neKTpaUecKOPO Hna axyCTHuecxoO npHCMHHKOB 31 H 34 npOHCXOJ(14T c HOMOnjbio 6BICTpoge cTH3lonigx 9JICKTpOHbHIX Rummell 5, 6, 26. CHrHan c 6noKa ynpaBneHHc 1 nogae'rm Ha ynpaBnmom;nil BXOjj 9TieKTpoaHOo Knloua 5, (6 26) pa3MaKacI gem, nHTaHHcI xa7Kj(Or0 H3 na3epoB. IlpexpanjeHne HMnynbca H3ny<sup>1</sup>ICHHR 9 CKT14BH0, eCrIH BpeMci OTKijOuCH14SI miTaHHcI McHbme jITHTPaIbHOCTH HMnyJmca H3nyeHHcI. (AnwTenbHOCTb HMnybca H3nyCHHR M07KCT' 6bITb 150-500 i c. ). 1109TOMy B KaecTBe 9neKTpOHHOo Knloua J ovi KCH HCIOYIb3OaTbCSI 9nCMCHT c BbICOKHM 6bICTpor etteTBHeM. Taxman ynpaBneMbnmm xnlouaia SHEITMo'r 'ci nOTIynOBOJIn1KoBble HRH 9neKTpOBaxyyMHble nepexnlouaTenH, BpeM5 cpa6ammaHHcI KoTOpbx He npeBbIIIaeT 100 Mice.

OpomeHHe 6HOTKaHH c HOMOIW,IO eHCTCMbi 17 npoHCXOJ ITT cnepyx►ng4M o6pa3oM. 143 pe3epHyapa jInCI BOHbl c BOjHHbIM HacocoM 35 Hog a 3anonHcic'r BOJ(onpoBo) single Tpy6KH 18. B cnyae Heo6xoJjaMocTH opomeHHcI TKaHH CHPHaHbi H3 6noxa ynpaBneHHH 1 IOCTynaOT Ha 9TCKTpOMaIHHTHMI KnaHaH 37 (38, 39), KoTOpbli oTKpbinaeT nOCTynneHHe Bo3pyxa nOH HaBneHHeM H3 B03JyHHOPO Koinpeccopa 36 B B03JyXOnpOBOH 19. KOHII, I BOJ;o- H Bo3pyXOnpOBOJcIH,HX Tpy6OK 18 H 19 paCyOn03KeHbi B HaKOHe'HHxaX 11 (14, 24) TaK, <sup>1</sup>TO nOCTynneHHe BOHbl Ha HppHranFioHHbie BbIXOjhl yCTpOIITBa HpOHCXOJ ITT npH nojja'ie Bo3jpnca no npIHU,HIry IlynBepa3a'ropa.

CHrHanbi H3 6noKa ynpaBnemui 1 noeTynaloT Ha 9RCKTpOMaPHHTHbIC KnaHaHbi 37 (38, 39) uepe3 nHHHH 3aHCp2KKH 40 (41, 42) OjHO6pCMCHHO c CHrHanaMH 3anycKa LIMIIynBOB reuepagza na3epoB 3 (4, 20).

OpolneHHe 6HOTKaHH BOJ OIII) OWKHO npOHCXOJ 11Tb B npOMC}KyTKaX Me}KJy HMIIynCaMH H3TiyehHcI na3epoB (c genbio H36excaTb HeKCenaTellbHOe pacceIHHe H3nyeHHH H IOBbICTb 90ieKTHBHOCTh OpOmeHHH), n09TOMy jInHTenHOCTb BpeMCHH 3aHCp2KKH RHHHLI 3ajjepcxKH 40 (42, 42) paBHa BpeMeano JWTenbHOCTH HMnynBOB H3Jy<sup>1</sup>TeHHR na3epoB c yueTOM BpebneHH noczylbleHHcI B03JL Xa K KOHgaM Tpy6OK 19.

IIpHMep KOHKpCTHOLI peanH3aIHH 3aRBnsreMbIX yCTpOICTB COCTOHT B Cnejjy01IjCM. BTIOK ynpaBpeHHR 1 (4Hr.5) COCTOHT 113 yCUIHTCT H BXOjHbIX CHPHanOB c HHTepaToMOM (CM. IBIaCneHHHKOB B.B. CHOTHH A.II. "LI36HpaTenbHble RC yCHRHTenH M. 3HeprHR, 1980, cTp. 69) BOCbMHKaHanbHOPO JjeCHTHpa3pSIjHOo aHaTIOPO-11W pOBOPO npeo6pa3oBaTenn (ALM) c nocneJjoBaTenbHbIM HHTeprDe2COM max 192 cepHH (cM. KaTanop MAXIM 1993), npoqeccopa PC-104 c KBapTeBbIM renepaToMOM (CM. KaTanop KoncoplayMa Advantage real time devic AMPRO, 1993 cTp. 103-184) H BOCbMHKaHanbHOo TpeHHajjaTHpa3pSI HOo IIudipallanoroBoro npeo6pa3oaaTens (LLAI) c nocneJjoBaTenbHbIM HHTep4el7icoM max 540 cepHH (cM. KaTanop MAXIM 1993). BbIXOjHble CHPHanbi LLAI <sup>1</sup>BTISNOTCB BbIXOjjaMH 6noxa ynpaBneHHcI 1, no TpeM H3 KOTopbIX, KpOMe CHPHanOB 3anyCKa HMnynBOB renepagaa, IOCTynaOT CHrHanbi, onpejjenRiomyio BCn1ILIHy 3HeprHH Ha KOHTenbHbIX KOHJ;CHCaToPOB 6noxa nWTaHHR 2 (CM. BORKOB 14. B. "ICTO<sup>1</sup>HHKH nHTaHHR na3epoB", TexHHKa, KHeB, 1976, cTp.118).

B Ka<sup>2</sup>ecTBe na3epoB Hcnon3yioTcs na3epbl: Nd:YAG (jInmHa Bonnbi 1,06 maim Hna 1,32 MKM, Ho:YAG (i rmna BOYHbI 2,09 MKM) H Er:YAG (jVmHa BOnlibi 2,94 MKM). B KaecTBe J;HCnepcnoHHoro 9neMeHTa 28 CTCKnsHH 51 npH3Ma, B xaecTBe 4oTogeTeKTopoB 29 KpeMHHeBble IOHynpOBOJHHKOBble (OTOjHOHbi 441-256, a B KaecTBe 410T09neKTpHuecKOPO np14eMHHKa HHd)paKpaCHOo 113TiyehHR 31 repMaHHeBbn7i 4poJ Ito) <sup>1</sup>I -9. 9neMeHT cpaBHejIHC 30 MHKpocxeMa K554CA3 min LM-111. AKycTHuecKH7i np14eMHHK 34 MHKpoOH B K4138.

Tatum o6pa3oM, npegnapaeA,Ible ycTpoICTBa 3a CueT c0BOxyIIHOCTH 3annncieMbIx npa3HaKOB, o6ecneLIHBan onepaTHBHoe ynpaBneHHe c B03MOHKHOCTbIO BapbHpOaHHR B IIHpoKOM jIlana3oHe napaMeTpaMH na3epnoro 113TiyehHR, H03BOnRIOT npOBOJHTb xapyprHuecKHe npogetpbl Ha 6HOTKaH\$X B KaecTBe nH6o CKanbnens, na6o KoarynsToPa, nH60 jjeCTpyKTopa B 3aBHCHMOCTH OT Tpe6yembx THPOB, pe7KHMOB H cogeTaHn paOTbI na3epoB, OpHeHTHpOaHHbIX Ha MHHHManbHyIO TpaBMaTII<sup>1</sup>HOCTb npH jJaII40M BHje B03Jje2CTBHR Ha jjaHHyJO 6HOTKaHb.



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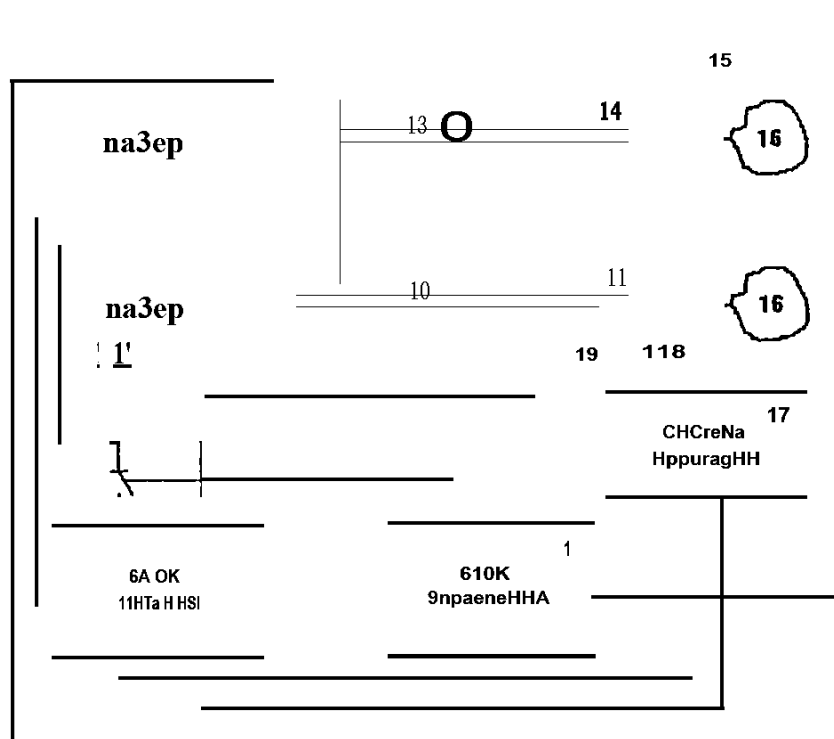
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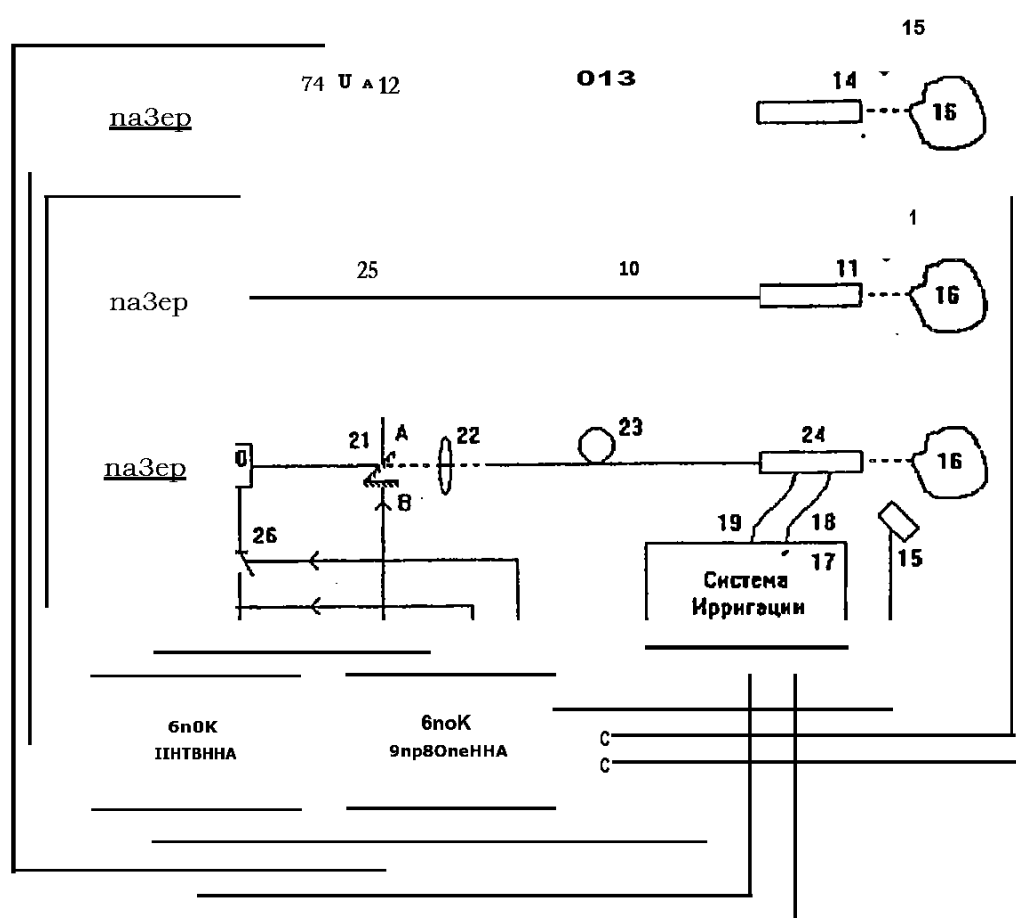
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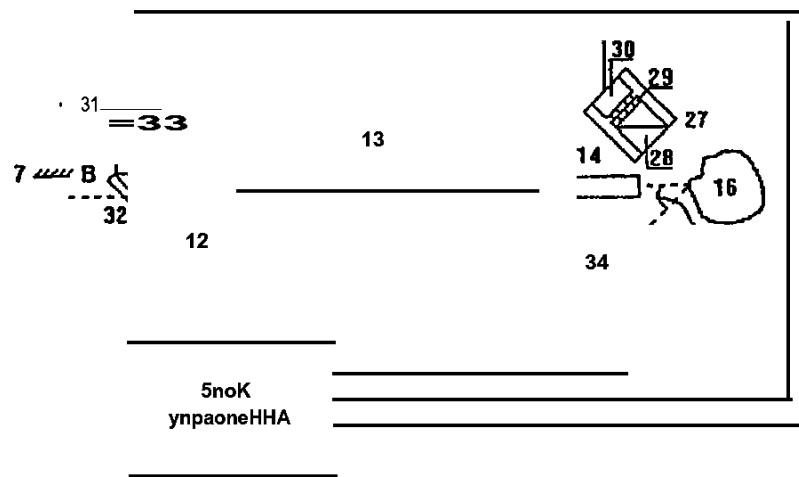
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7. YCTpoCTBO no nn.1 H 2, o'rnnualonweecB TeM. tiro ono J;ononHHTenbno cna6meno cHCpeMOH<sup>2</sup> opoivemiH 3oHbi o6pa6o'rKH, coCroslllleil H3 ne3epnyapa J~nsl BOJ;bI c BoJ;siHbnM HacoCOM 11 BO3J;pynnop0 KoMnneccopa, C00TBCTCTByIOHVHC BbIXOJ; ы KOTOpbIX o6'beAHHeHbi B HaKOHenHHKaX H 3IB3\$IIOTCII HppIlral[HOHHbIMH BbIXOJ;{aMH yCTpOIACTBa, a BO3J;YwbII<sup>1</sup> KOMnpCCOp B MCCTC coe nHeHHCI c BO3J;lyX0IIpOBOAaMH CHa6?KCH 3IIeKTpOMarHHTHbIMH KnanaHamlll, nOJ;KnIOHeHHbIMH K BbIXOJ;aM 6noKa ynpaBneHHCI.

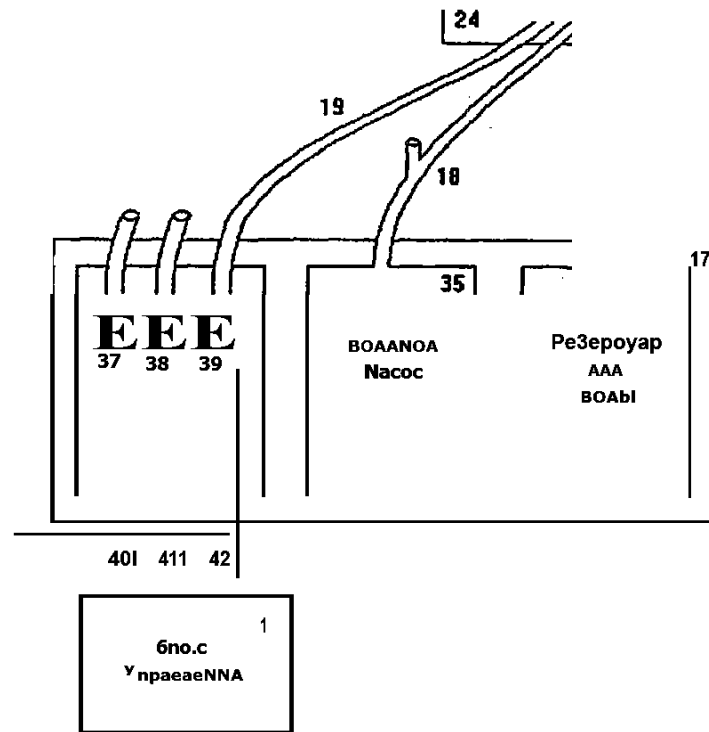
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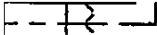


BAB

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